A large, light blue watermark of the NASA logo is centered on the page. It features the word "NASA" in its characteristic font, with a white orbital path and stars in the background.

**NASA & Army Collaboration
on Unmanned Systems
Presentation to the AUVSI**

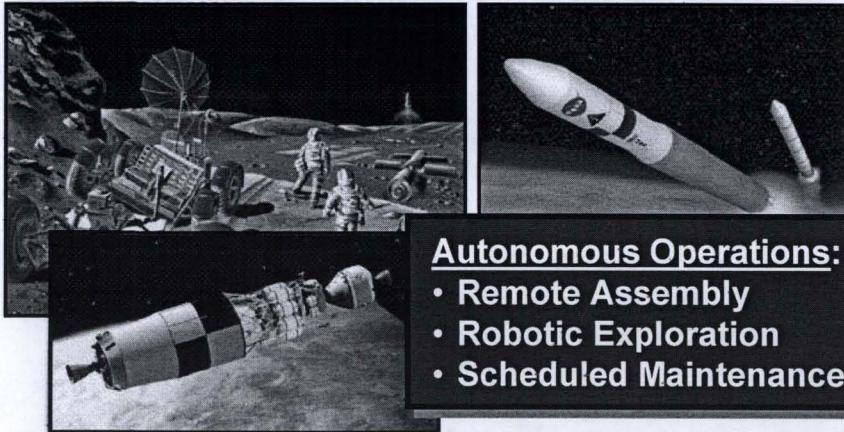
Dr. Ken Fernandez

April 24, 2008

Robotic/Autonomous Systems Architecture Development



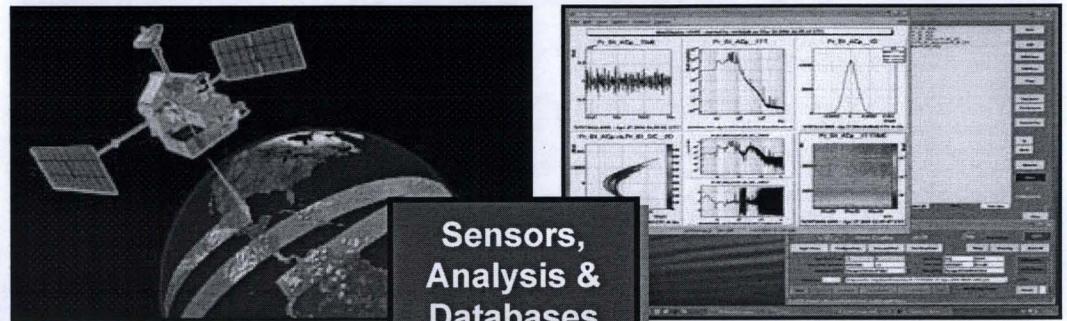
Lunar Exploration Infrastructure



Autonomous Operations:

- Remote Assembly
- Robotic Exploration
- Scheduled Maintenance

Elements Of Robotic/Autonomous Systems Infrastructure



Sensors,
Analysis &
Databases

C3I

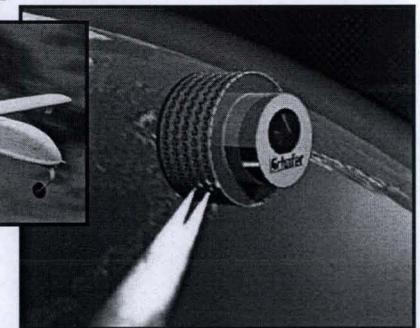
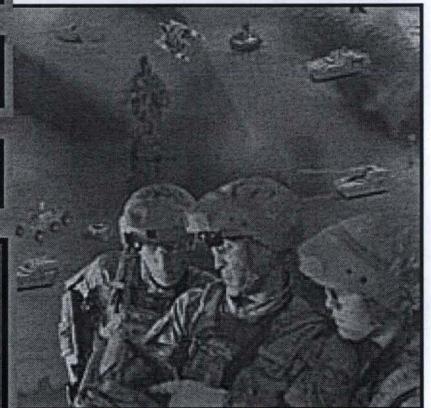
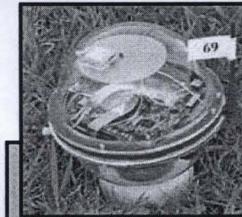
Networks

Mobility
Platforms

- UGVs
- UAVs
- MicroSat

Challenges Involving Robots:

- NASA - Autonomous Local/Remote Operation, Command & Control of Multiple Robotic Vehicles, Sensor Networks, Lunar Resource Utilization And Repair, Lunar Environment, Distributed Users
- DoD – Autonomous Operation, Platform Integration, Networks, Deconfliction, Affordability, Durability, Weaponization, Security, Multiple Users, Common Operating System



Robotic Requirements Are Synergistic Between NASA and DoD

Synergy In Robotics/Autonomous Systems Development



NASA

Collaborative Effort For
Common Systems & Technology

DoD Robotic Systems

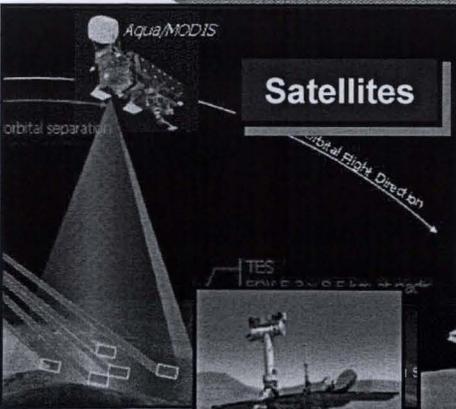
**Big Network
Demonstration**

**Battlefield
Whiteboard
Demonstration**

Collaboration With
Astronauts
In Situ Resource
Utilization
In-Space Operations

Mapping & Locating
Collaborative Operations
Sensing & Reconnaissance
Infrastructure Maintenance
Cargo/Materiel Transport & Logistics
Maneuvering/Power Systems
Scientific Measurements
Medical/Emergency
Satellite Servicing
Security

Offensive Operations
Maneuver
Common Operating
System
Weapons



Satellites

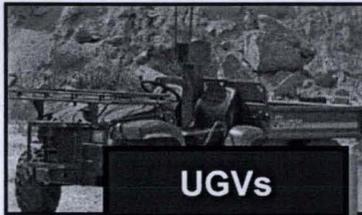
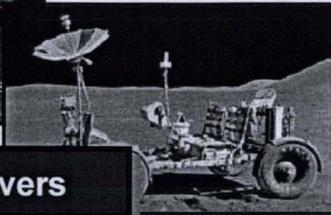


Networks

*Develop and demonstrate technology and
integrate into systems of common interest to
several agencies*



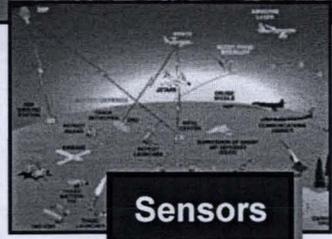
Rovers



UGVs



UAVs



Sensors

**Concentrate On Developing And Demonstrating Capabilities That Are Common
Between NASA Lunar Infrastructure And DoD Robotic Systems**

Surface Mobility Systems: Lunar Pylon Network Project



Master Node

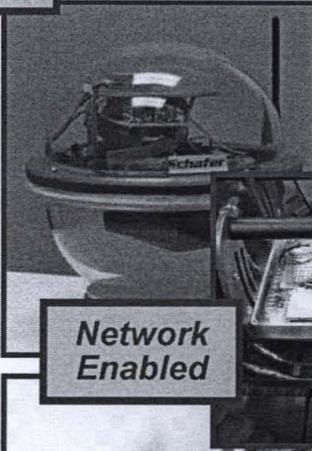
- Command & Control
- Auto Pilot



- Lunar Pylon Network: Self-aware, self-healing navigation and communication network for surface exploration and science
- Demonstrate autonomous waypoint navigation using a variety of surface mobility platforms
- Collect sensory data and perform mapping including hazard detection and avoidance
- Demonstration of navigation beacons to support automated landing and surface operations

COM/NAV Node

- Encrypted Communication Relay Network
- GPS For Location
- Sensor Interface
- Situational Awareness
- Platform Independent



Network Enabled

GPS

Cameras

Vehicle Node

- COM/NAV Node
- Monitor & Control Autonomous Way-Point Navigation



NAV

Situational Awareness

Relay COM

Node 3

Computer Control

Relay COM

MSFC Building 4614 Testbed

Node 2

Google Earth™

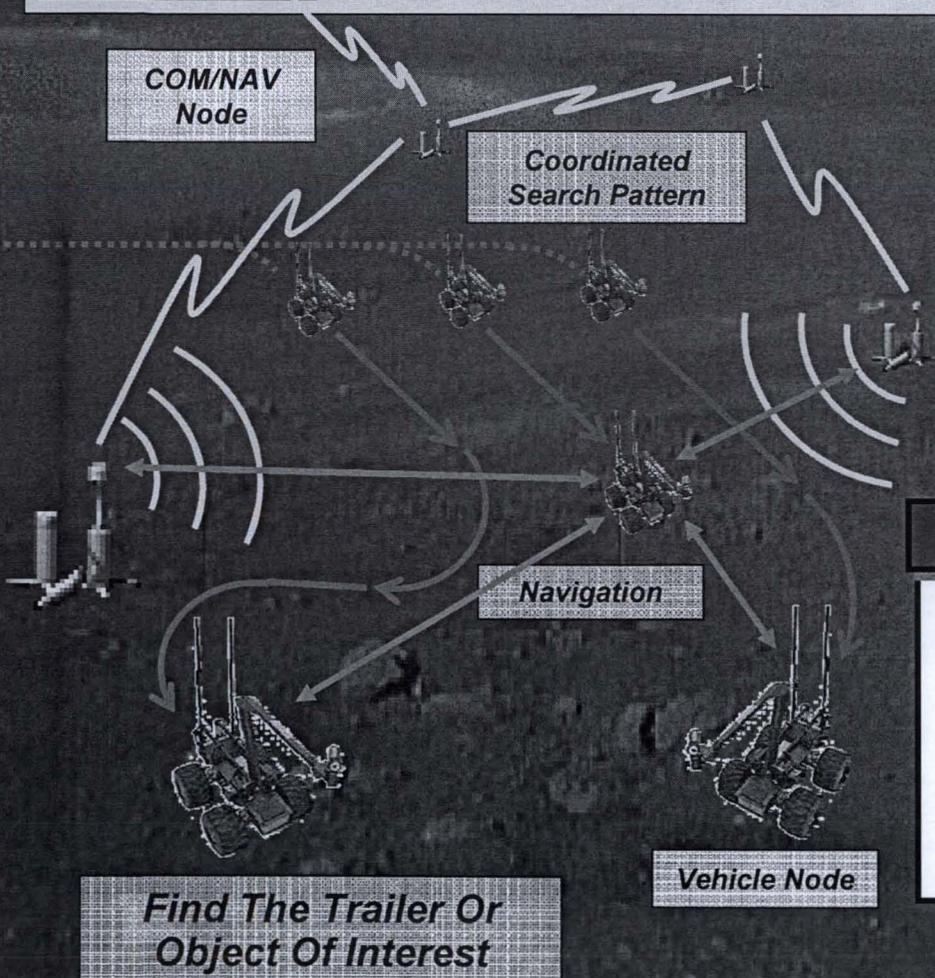
Demonstration Of Precision Navigation With Communication Between Multiple Vehicles Simultaneously Operating Within A Network



Mission Concept: Search For Objects Of Interest



- Network And Sensors Identify Objects Of Interest And Prepositioned Equipment
- Operator Commands Multiple Robots Towards Object Using COM/NAV Network
- Autonomous Behavior Programmed Into Robot Supports Operator Decisions



- **Modify MARCbots IV From RS-JPO With Node To Provide Interface To Network And Control**
 - Network Gives MARCbot Position Sensing And Communications Capability
- **Explore Operations Schemes**
 - Using Simulations, Develop Approaches To Have One Operator Control Multiple Vehicles To Accomplish A Task
 - Combine Network And Robot Sensors To Generate Situational Awareness (Find Trailer)

MARCbot IV



Modified MARCbot IV Offers Economical Approach To Exploring Multiple Vehicle Operations, Control Schemes, And Sensor Suites

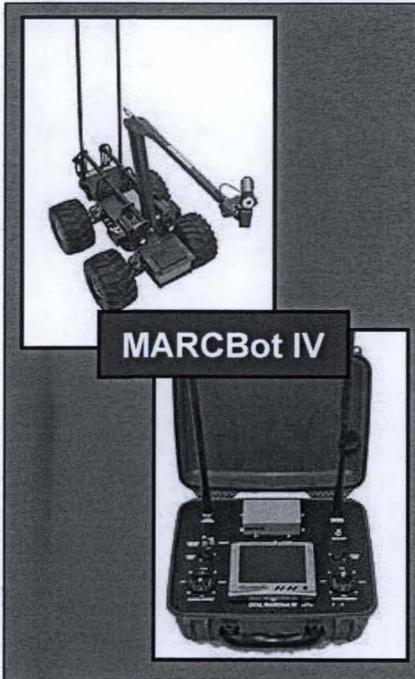
MARCbot IV-N



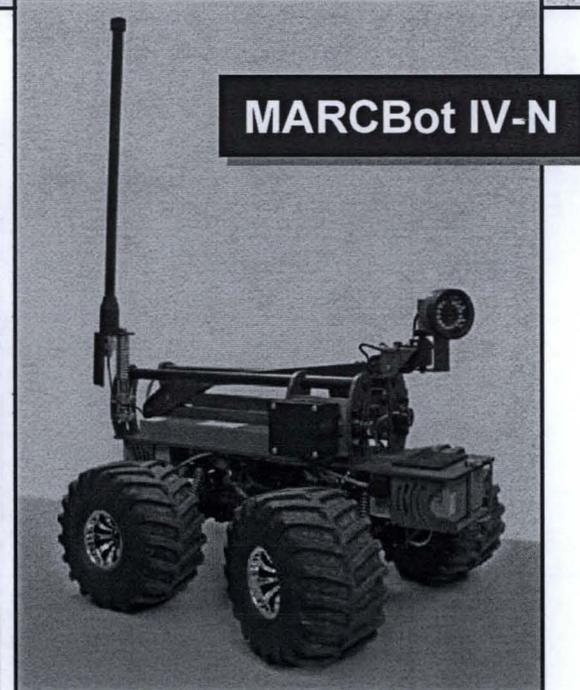


Transition NASA Development Effort To Support RS-JPO:

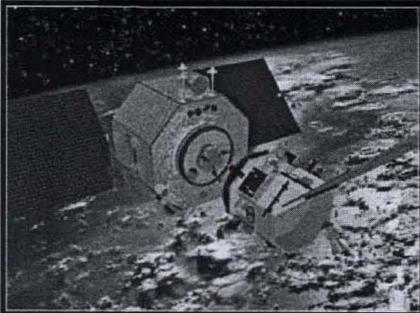
- Add navigation and communication capability to support situational awareness with FalconView
- Computer based OCU and Line Replaceable Unit with secure communications
- Enhanced imaging and provide digital video recording
- Provide autonomous waypoint navigation
- Demonstrate affordable system with extended range



- Reused Hardware:
- Robot Chassis
 - Robotic Arm
 - Electrical Power Supply



1 Advanced Video Guidance Sensor (VGS) Technology was used to perform the first Autonomous Docking in US history on Orbital Express



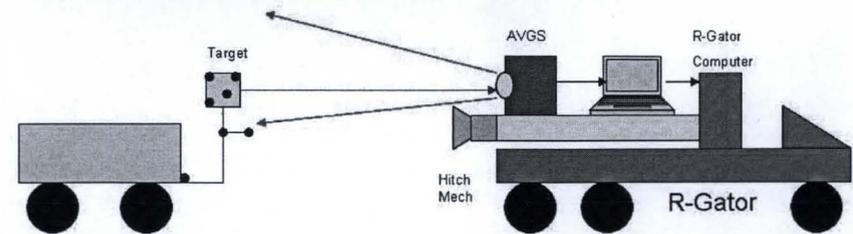
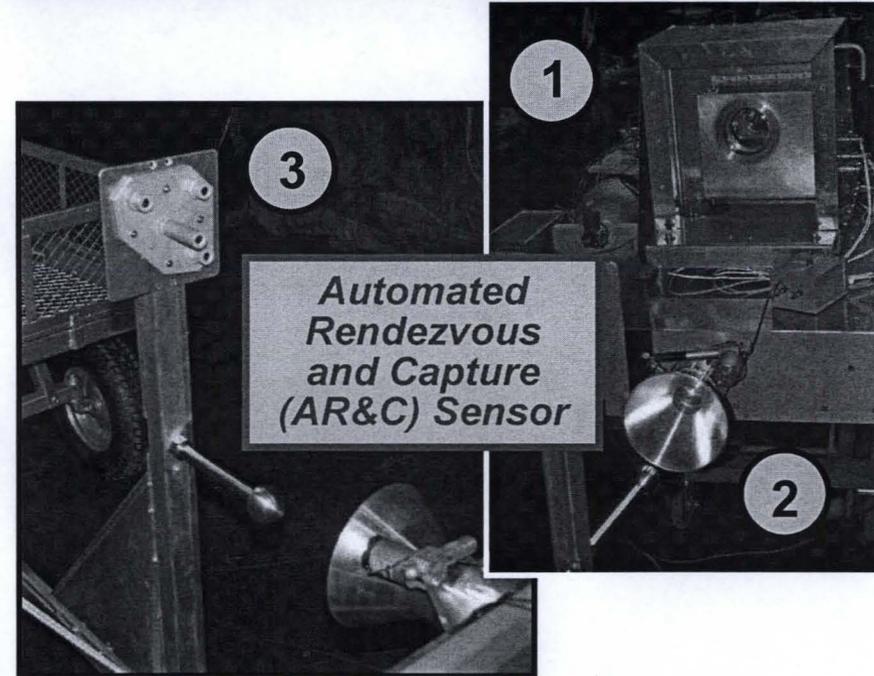
- Measures relative range, bearing, and attitude between the sensor and its target with no moving parts
- Nominal range: 1 meter to 300 meters

2 The Hitch is a MSFC developed Ball Joint Docking Mechanism for passive latching

- Hitch is retained by radial force of 3 balls pushing against locking ring
- Align the locking ring's release grooves with balls by linear actuator cam action to unhitch
- Integrated Proximity sensor provides feedback of hitch position to vehicle

3 The demonstration trailer was modified with a target pattern and a hitch fixture

Mission Concept: Search For And Retrieve Prepositioned Equipment





Lunar Network Demonstration Has Synergistic Goals With The AMRDEC Battlefield Whiteboard

- Meet a critical astronaut (warfighter) and mission control (field commander) need – enhanced situational awareness from information convergence – by integrating critical assets at Redstone, both NASA and DoD.
- Develop and deploy a technology platform to test and validate the underlying technologies and systems.
- Capitalize on prior technology initiative and industry investments to enable deployment of a concept demonstrator in less time and at lower risk and cost.
- Validate a model that enables government, industry, and the university research community to share their technical strengths.

